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Functional Requirements Definition for a Mobile Offshore Base (MOB)

Abstract

The Office of Naval Research has assumed leadership of a non-acquisition Science and Technology program focused on the advancement of critical technologies required to reduce the technical, operational and financial risks of designing, constructing, operating and maintaining a Mobile Offshore Base capable of meeting mission requirements. The overall goal of the program is to establish technical and financial feasibility of a MOB.

Although the requirements for an actual MOB would be developed as part of a formal system acquisition process, it was realized that a consistent set of mission-based functional requirements was needed to help bound and guide the S&T program. This paper describes the purpose, derivation and database documentation of these requirements, and identifies those mission requirements that are expected to drive the physical requirements of the structure. An overview of the Mobile Offshore Base Science and Technology program is also included to provide the context for the requirements definition work.

Introduction

The recent crisis in the Persian Gulf as well as the opposition to the U.S. military presence on Okinawa have recently renewed the interest of Pentagon officials in the Mobile Offshore Base (MOB) as a way to ensure U.S. military access to critical regions. The ability to project combat power rapidly and virtually unimpeded to

widespread areas of the world is the cornerstone of the U.S. Defense strategy. By serving as a sea-based conduit for logistics support, MOB could provide indefinite sustainment capabilities, allowing U.S. forces to conduct Combat Operations and Operations Other Than War (OOTW) in areas lacking adequate basing structure. The MOB would enable a continuous flow between bases located in the U.S. or overseas, and elements conducting operations ashore or at sea. In the recent past, small offshore bases have been successfully used in various temporary configurations to support joint operations in Vietnam (1967-72) and in the Persian Gulf (1987-89). While deployed at a lesser scale than the future Mobile Offshore Base to support Special Operations Forces (SOF), they clearly demonstrated the advantage of establishing a sea-based conduit for logistics support in areas and under conditions which precluded development of adequate or timely basing ashore.

In concept, a MOB is a large floating platform, on the order of 1500m long by 120m wide. MOB provides aircraft operations capabilities up to the C-17 cargo transport aircraft, cargo loading and offloading from military sealift and commercial cargo ships, provides internal cargo storage and handling facilities, and personnel support facilities for up to 20,000 personnel dependent upon the type of mission. Most MOB concepts proposed to date consist of multiple large semi-submersible modules, connected by various means to provide a functionally continuous platform. The size of the individual

modules and connector mechanisms making up these different MOB concepts is well beyond current practice in the offshore industry.

MOB Science and Technology Program Overview

Enabling technologies for the MOB were first investigated by the Defense Advanced Research Project Agency in 1993-1995, with the ultimate objective of conducting an Advanced Concept Technology Demonstration (ACTD) of the MOB. However, it was determined that the unprecedented size and requirements of the MOB translate to unacceptably high risks using present-day technology to design, construct and operate such a platform. Therefore, the Chief of Naval Operations directed the Office of Naval Research (ONR) to assume leadership of a Science and Technology (S&T) program focused on reducing these risks. The goal of the S&T program is to advance critical technologies required to reduce the technical, operational and financial risks of designing, constructing, operating and maintaining a MOB capable of meeting mission requirements. The focus of the program is on establishing the technical and financial feasibility of a MOB.

The ONR S&T program consists of the following four general product areas: Mission Requirements and Performance Measures, Standards and Criteria, Design Tools, and Alternative Concepts. Each of these efforts is described briefly in the following sections.

MISSION REQUIREMENTS AND PERFORMANCE MEASURES

The objective of this task area is to define a set of mission-based functional requirements for a MOB, a rational procedure, and the necessary tools for evaluating alternative concepts on the basis

of functional performance, operational availability, and system cost. These data and tools will provide a consistent basis for the development, refinement and evaluation of different MOB concepts. They also will provide the means for ensuring that the S&T program is focused on solving those technology issues most important to meeting critical mission requirements for the MOB. The products resulting from these efforts will include:

- Concepts of Operations (CONOPS) and System Capabilities Documents (SCD) for the MOB, derived from the existing Mission Need Statement (MNS). These documents set the framework for establishing a set of mission-based physical and operational requirements for evaluating the functional feasibility of different concepts for the purposes of the S&T program.
- Hierarchical database containing MOB platform capability requirements and the functional requirements necessary to achieve those capabilities, all linked to each mission element. This database serves to document the requirements derivation process, and also can be used to perform sensitivity studies to evaluate the impact that changes in missions have on functional requirements for the MOB.
- Operational availability model for the MOB. This model will be used to assess the performance of any MOB concept relative to the mission-based requirements, and will allow an evaluation of the sensitivity of various performance parameters to changes in concept configuration and mission requirements.
- Cargo Transfer rate model for transfer of Lift-On/Lift-Off (LO/LO) and Roll-On/Roll-Off (RO/RO) cargo between the MOB and vessels alongside. This

model allows evaluation of operational performance of different concepts in the critical area of cargo loading and offloading for various ships and lighterage over a range of environmental conditions. This model also will provide direct input to the Operational Availability model.

- Expansion of existing ship design synthesis models. These models will be used to evaluate the impact of changing mission requirements, technology capabilities and operating environments on system performance and cost. They also will be used to evaluate the completeness of alternative MOB concept designs in terms of basic geometry and space and volume requirements, and required subsystems and subsystem capacities (e.g., power requirements).
- Constructability risk assessment and development of risk-based constructability guidelines. This effort will evaluate the constructability risk in terms of schedule and cost for each alternative concept considered in the S&T Program. In addition, risk-based constructability guidelines will be developed and incorporated into the *Classification Guide* described below.

STANDARDS AND CRITERIA

The Standards and Criteria product area will result in the development of a draft MOB *Classification Guide*, addressing structural safety and integrity. This task includes the development of reliability-based design standards applicable to MOB-type structures and the definition of environmental and fatigue criteria for the MOB. The *Classification Guide* will be the primary technical deliverable from the MOB S&T program. The Guide establishes a common design reference for both contractors and

government to help ensure that each ongoing and future developed concept for the MOB is designed as accurately and realistically as possible relative to the functional requirements.

The American Bureau of Shipping (ABS) is tasked to develop the *Guide* by extending existing offshore practice and standards to accommodate the MOB, and integrating military standards where appropriate. The *Guide* will specifically help the offshore industry plan and execute the design of a MOB, and guide ABS in the certification of a MOB design. The *Guide* will also benefit the offshore industry and other commercial sectors in general, as it will be applicable to a broad variety of Very Large Floating Structures (VLFS), such as offshore airports, processing plants, storage facilities, or habitations.

Along with structural design guidance, the Guide will define the environmental and fatigue criteria for a MOB. However, no mathematical, laboratory or field studies of ocean waves have ever been conducted at the spatial scale of the MOB. A better understanding of the environment and its impact on structures the size of a MOB is required before fatigue, operational and survival environmental conditions can be specified in the Guide. Three interrelated efforts within the Standards and Criteria product area are directed towards achieving this goal. They include evaluating all existing theoretical and measured information regarding wind, wave and current environments as they affect the MOB platform design, and advancing the understanding of wave spatial coherence needed to address structures as large as the MOB through both experimental and field investigations.

DESIGN TOOLS

The objective of the Design Tools product area is to develop a suite of validated

computer software that will allow the accurate evaluation of hydrodynamic and structural behavior of MOB structures. Existing hydroelastic models are numerically inadequate for analysis of structures on the scale of MOB modules, leading to sacrifices in accuracy to decrease computation time. In addition, none of the existing hydroelastic simulation models have been validated, and the models have had limited application to the analysis and design of very large floating structures like the MOB. The products of the Design Tools effort will include:

- Evaluation of existing analysis and design tools and models.
- Development of advanced hydroelastic models adequate to address structures on the scale of the MOB. Two separate models using different approaches are being developed to reduce risk and to serve as checks against one another.
- Development of a “load generator” tool to provide a numerical interface between frequency domain hydrodynamic analysis and time domain structural dynamics methods. This will permit the analysis of non-linear structural effects and non-linear structural members, such as advanced compliant connector designs.
- Generation of new physical model data to validate the design tools being developed.

ALTERNATIVE CONCEPTS

Alternative concepts for an overall MOB, as well as concepts for specific critical components such as connectors, are being advanced under this product area to both advance existing technologies and identify additional technology gaps. By sponsoring the development of competing point designs

for the MOB and some of its specific components, the shipyard and offshore industry helps identify and fill its own technology gaps. The following four MOB system concepts will be developed through the preliminary design stage as part of this effort.

- **Hinged Semi-Submersible Module MOB.** Comprises up to five semi-submersible steel modules up to 300m long, connected with compliant hinge-type connectors (Figure 1).



FIGURE 1. Hinged Semi-Submersible Module MOB

- **Semi-Submersible Modules Connected by Flexible Bridges:** This concept consists of three semi-submersible steel modules, each about 235m long, connected by long (410 m), full width flexible truss “bridges” that provide a continuous flight deck (Figure 2).

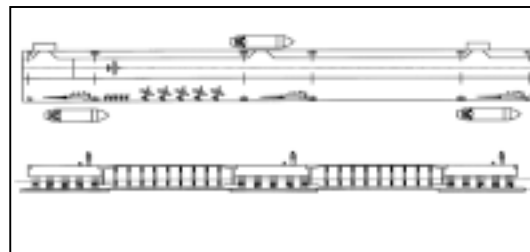


FIGURE 2. Semi-Submersible Modules with Flexible Bridges MOB (plan and elevation views, respectively)

- **Independent Semi-submersible Modules.** This “non-connector” concept is made up of three very large (490m) semi-submersible steel modules that are only functionally

connected by drawbridges to span the gap between dynamically positioned modules providing a continuous airplane runway. This concept relies on dynamic positioning to maintain overall orientation and relative position between modules, instead of structural load-bearing connectors (Figure 3).

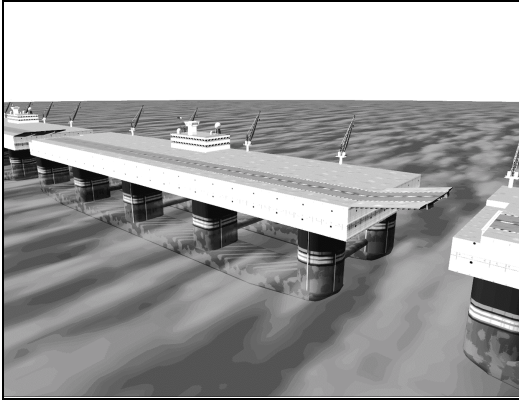


Figure 3. Independent Semi-Submersible Module MOB

- Concrete and Steel Semi-submersible Modules. This concept consists of 380m long semi-submersible modules connected with compliant elastomeric bearings, with a concrete hull and steel deck. A concrete hull may provide a longer life and require less maintenance (Figure 4).

In addition to these four concepts, a fifth concept comprising steel semi-submersible modules connected with a rigid connector system was already fully developed to the preliminary design stage under the original DARPA program. While the initial work on this fifth concept is completed, all five

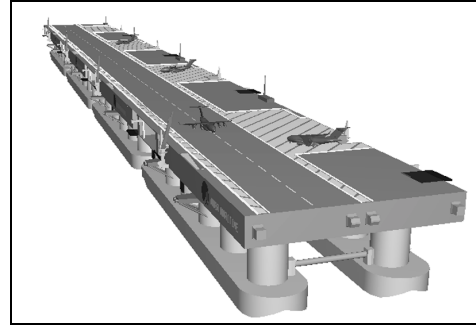


Figure 4. Concrete and Steel Semi-Submersible Module MOB

concepts will be evaluated as part of the S&T program.

The ship design synthesis models mentioned earlier also will be utilized to develop conventional ultra-large monohull alternatives to meeting MOB mission requirements. While these monohull concepts will not be capable of meeting all MOB mission requirements, they will serve as a familiar point of departure and comparison of feasibility and cost of other MOB designs.

In addition to the system concepts described above, the following specific components are also being addressed within the Alternative Concepts product area:

- Connectors, including specific connector concepts not addressed in the system concepts described above, connector materials, and connection methods in general.
- Multi-module Dynamic Positioning (DP) systems
- Pneumatic stabilization method for platforms.
- High capacity mooring lines and suction pile anchors.
- Lightweight decking materials
- Cargo transfer systems.

Requirements Definition Task Objectives

The primary focus of the MOB S&T program described above is the advancement of critical technologies to reduce the technical, operational, and financial risks of designing, constructing, and operating a MOB for an actual mission. Although the requirements for an actual MOB will be developed as part of a formal system acquisition process, it was realized that a consistent set of mission-based functional requirements was needed to help bound and guide the S&T program. The principal benefits of the requirements definition task are discussed below.

SUPPORT CONCEPT DESIGN AND EVALUATION

The principal purpose of defining a consistent set of functional requirements, translatable into engineering units, is for evaluating the functional feasibility of alternative MOB concepts, and to serve as the basis for future concept development and refinement. Previously, without a well-defined set of requirements, it was left to the individual system concept designers to interpret the Mission Need Statement and to develop the specific platform capabilities and functional requirements upon which to base the design of the MOB. Because of the very broad nature of the initial MNS, this led to a wide range of design goals adopted by different concept designers. This in turn makes it very difficult to compare the advantages and limitations of different system concepts on the basis of functionality and cost. Establishing a set of supportable and traceable requirements for the MOB system will provide the basis for a consistent and fair evaluation of existing alternative concepts, as well as serving as the basis for future concept development and refinement.

PROVIDE INPUT TO STANDARDS AND CRITERIA DEVELOPMENT EFFORT

Some of the MOB requirements will have direct impacts on the standards and criteria being developed as part of the MOB *Classification Guide*. For example, the survivability requirements identified for the MOB require suitable structural design criteria to ensure that the MOB can survive against the projected threats.

EVALUATE SENSITIVITY OF MOB SIZE AND COST TO CHANGES IN REQUIREMENTS

Using the requirements database, design synthesis model, and operational availability model described in the program overview earlier along with the baseline requirements will allow the program office to evaluate the sensitivity of MOB size, availability and system cost to changes in one or more requirements.

VERIFY SCIENCE AND TECHNOLOGY PROGRAM DIRECTION

One of the most important benefits of a well-defined set of requirements to the S&T program is the ability to compare mission-based requirements to existing technology capabilities. This comparison will enable the program office to verify that the S&T efforts are focused on solving those technology problems most critical to meeting the MOB's mission requirements. In addition, sensitivity analyses performed using the performance measurement tools and these baseline requirements will also help determine where technology advances can provide the most value in improving MOB reliability and performance. This will help guide the allocation of limited resources where they will achieve the most benefit for the program.

ESTABLISH AND DOCUMENT REQUIREMENTS DEFINITION PROCESS

A key aspect of this effort is to develop a consistent methodology for deriving the functional requirements so that the process can be replicated as MOB missions evolve over time. This will also help ensure that new requirements are complete and available in a format suitable for use in the performance measurement tools described earlier.

Functional Requirements Derivation Process

A systems engineering based process was selected for deriving the specific mission-based functional requirements for the MOB. This process begins with the 1995 MNS for the MOB, and methodically deconstructs the broad-based MNS into multiple discrete missions for which a Concept of Operation (CONOPS) is developed. In turn, each CONOPS serves to establish the basis for a Platform Capabilities Document, which leads to the definition of specific physical and performance requirements associated with each capability. These physical requirements are the data of most value to designers establishing the design goals for a MOB. This derivation method also lends itself to documentation in a hierarchical database, linking specific mission requirements to platform capabilities, each in turn linked to specific functional requirements.

Each step in the requirements derivation process is described in the following sections. An overview of the requirements database is presented later in this paper.

MISSION DEFINITION

The basis for the derivation of functional requirements to support the MOB S&T program is the "Mission Need Statement

(MNS) for the Mobile Offshore Base" dated 15 September 1995. While this document has not gone through the required Joint Requirement Oversight Council (JROC) process, it is the only authoritative document available providing guidance towards requirements for an actual MOB and was therefore adopted as the starting point for the requirements definition process. Some of the major objectives for the MOB included in the MNS are summarized below:

- Maintain continuous overseas presence and theater access complementary to, or independent of, allied or coalition support and infrastructure.
- Extend and maintain operational reach within a theater of operation.
- Conduct pre-planned and crisis-generated operations, at any level of engagement or conflict, in any area of the world. These operations include military-to-military contacts, humanitarian operations, security assistance, peace operations, counter-terrorism, special force operations, power projection, non-combatant evacuation operations, lesser and major regional contingencies.
- Stow, maintain, and deliver selective and ready afloat pre-positioned equipment, fuel, and water.
- Provide an advanced base from which air, land, and naval expeditionary forces can conduct operations complementary to, or independently of, host-nation support.
- Provide an in-theater command and control (C²) center and operation facility directing and supporting air, sea, and land systems and providing command, control, communications, computer, and

intelligence (C⁴I) capabilities to Joint Task Force (JTF).

- Provide a tactical aviation operations and support base for CTOL, STOL, VSTOL, and rotary wing aircraft.
- Provide a base capable of launching and recovering SOF missions employing SOF aircraft and maritime assets.
- Provide supplemental or alternative capability to land-based naval advanced logistic support sites and naval forward logistic sites, to include refueling and re-supply of military units.
- Provide supplemental or alternative mobile pre-positioning of military combat, combat service, and combat service support equipment and supplies.
- Provide an inter-theater and intra-theater logistics node supporting movement of both pre-positioned and deployed equipment and supplies to required locations via both sealift and airlift assets including C-17.
- Provide a transportation node capable of supporting routine movement of combat and transportation assets, including current and future U.S. and allied commercial and military air and sea transportation and combat and surveillance aircraft and ships.
- Provide in-theater organizational, intermediate, and selected depot maintenance and repair facility supporting deployed air, sea, and land systems.

The statements above reflect the fact that MNS are intended as broad statements of general mission needs, making them open to wide differences in interpretation, as discussed earlier. Before meaningful functional requirements could be derived,

the contents of the MNS needed to be further clarified and refined into a CONOPS. However, because the MOB could actually support each of several independent military missions, serving as a large logistics base, or as a smaller platform supporting special operations, for example, it was decided to break the MNS itself down into several discrete missions for which CONOPS would each be developed.

Six separate missions for the MOB were initially identified for which CONOPS would be developed. These included the MOB as a logistics base, as a special operations platform, in support of tactical aviation, for operations other than war, as a sea-base supporting Operational Maneuver From The Sea, and as a pre-positioned equipment storage site and platform for the marriage of troops with their prepositioned gear.

The identification of these missions was based in part on how each would drive the physical requirements for the MOB. For example, those missions requiring aircraft operations for conventional fixed-wing aircraft would require a full-length, functionally connected MOB. Other missions involving only vertical take-off and landing aircraft and more modest storage and operating spaces may only require one or two units of a full MOB. Similarly, some but not all missions may require specialized facilities such as lighterage loading and offloading. Although a single MOB system would still be required to fulfill all of these discrete missions at various times, dissecting the overall MNS in this way allows for the consideration of specialized MOB modules making up the full MOB. This in turn allows for maximizing the flexibility of the system while reducing unneeded and costly redundancy of systems.

After outlining the basic operations and capabilities required to support each of these missions, the MNS was revisited to

ensure that every statement in the MNS was covered by at least one of the six preliminary missions. The next step in the process was the development of CONOPS for each mission.

CONCEPTS OF OPERATIONS FOR THE MOB

The six missions identified and described in the previous section were addressed in the development of CONOPS corresponding to each mission. The CONOPS developed for each mission describes the operational environment and the specific roles that the MOB plays in supporting operations. In addition to a general overview of the operations and how the MOB fits in, the CONOPS also describe operations involving or impacting the MOB during both the planning and execution phases of the operations. The execution phases include deployment and reception as well as operation. Notional force lists are included as a means of estimating the numbers of personnel and amount and type of equipment and aircraft to be supported for that mission. A scenario describing a hypothetical operation in a specific geographic location also is included to illustrate how the MOB might support a real mission.

During the course of developing the draft CONOPS, it was determined that the Operations Other Than War (OOTW) mission and capabilities were already covered within other missions (both logistics and special forces operations). Similarly, the Operational Maneuver from the Sea (OMFTS) and Marine Prepositioned Force (MPF) missions could be effectively combined. CONOPS for the four resulting missions were developed. Each of the four CONOPS is briefly summarized below.

LOGISTICS BASE

In this concept of operations, the MOB serves as a sea borne forward base in an overall joint “hub and spoke” logistics architecture which provides an at-sea terminal area to receive, warehouse, assemble and distribute equipment and supplies to sea, air and land forces. In addition, MOB has the capability to provide intermediate level maintenance and repairs for rotary-wing aircraft. MOB is employed across the full spectrum of operations including Combat Operations and Operations Other Than War (OOTW) where there is an absence of adequate support infrastructure or where operational concepts dictate using the sea as maneuver space.

SPECIAL OPERATIONS FORCES (SOF) MOB

A MOB providing or hosting operational level support for SOF, accommodates the spectrum of sequential and concurrent tasks required to stand-up the Joint Special Operations Task Force (JSOTF), facilitate preparations for operations, conduct operations and service support for long duration presence. Functioning as an operational base, the MOB receives and accommodates strategic re-supply and replacement as well as regeneration of combat units in contact with enemy forces and repair of assets needed to maintain operational readiness.

OMFTS/MPF MOB

In this CONOPS, MOB is part of the sea-basing concept for Maritime Prepositioning Force of 2010 (MPF 2010) and Beyond. MOB serves as a sea base with accommodations for up to 20,000 embarked MPF Marine Air Ground Task Force (MAGTF), facilities for assembly and staging areas, and facilities to effect sea-based command and control of the MPF MAGTF operations. MAGTF forces operate using the concept of OMFTS and

ship to objectives maneuver (STOM). The forces committed ashore are indefinitely sustained from MOB. Finally, MOB is capable of in-theater reconstitution and redeployment.

TACTICAL AIRCRAFT SUPPORT

This CONOPS addresses the MOB in a support role to other air-capable bases or ships, and covers missions in which tactical aircraft are operated in and around the MOB. Because the MOB is in a supporting role only, no aircraft are assigned to the MOB as a permanent base. Instead, the MOB provides support activities that enhance the productivity and flexibility of the bases and ships it supports. Potential missions for the MOB in this context include its serving as a divert field for tactical aircraft, a transshipment point for planned transit of aircraft into or out of the theatre of operations, and as a base providing routine operational support for aircraft operations. Operational support includes Carrier Onboard Delivery (COD), Intelligence, Surveillance and Reconnaissance (ISR), Search and Rescue (SAR), tanking support, and fuel carrier landing practice. Tactical aircraft addressed in those CONOPS include all U.S. Air Force tactical aircraft, U.S. Navy fixed-wing carrier-based aircraft, and U.S. Marine Corps fixed-wing aircraft, planned for operation in the 2010 time period.

PLATFORM CAPABILITIES DEFINITION

Following definition of the CONOPS for each mission, the specific capabilities required of the MOB to support that mission are defined and documented in a Platform Capabilities Document. In the S&T program, these documents are included as appendices to the CONOPS for each mission. The platform capabilities definition is the intermediate step between defining the concept of operations for a

mission and deriving the physical requirements needed to meet that mission.

As an example, some of the platform capabilities required of the MOB to support the logistics mission include:

- Organic C⁴I capability to support sea-based logistics planning and information support, including Joint Total Asset Visibility and Global Combat Support System.
- Selective offload capability including automated storage systems, re-configurable internal stowage spaces for vehicles, aircraft and containerized cargo, climate controlled storage space, warehouse capability and services, areas for marshaling, staging and breakout of cargo and equipment, and the capabilities needed to provide throughput of all classes of supply.
- Multiple vertical take-off and landing (VTOL) sites.
- Aircraft operations capability for fixed wing aircraft up to the C130 and C17, through seastate 6 conditions.
- Intermediate level maintenance, repair and battle damage repair on logistics aircraft, watercraft, and unit equipment.
- Aircraft hangaring facilities.
- Loading and unloading of commercial and naval ships, including LO/LO, RO/RO, oilers, lighterage and air cushioned vehicles through seastate 3.
- Fresh water production, distribution and storage.
- Ordnance and hazardous material handling, storage and transfer.

- Survivability against 21st century anti-ship missiles, torpedoes, and mines.
- Personnel support facilities, including berthing, messing, medical and limited recreational facilities.

FUNCTIONAL REQUIREMENTS DEFINITION

To define the specific physical requirements for the MOB, each platform capability requirement is analyzed to determine what physical requirements must be fulfilled on the MOB to provide that capability. For example, if the Platform Capabilities Document requires personnel accommodations for 15,000 troops to satisfy a particular mission, the amount of physical space needed for berthing, messing, and other personnel support facilities, is determined in this step. These requirements could then be provided to a concept developer as a design requirement for their version of the MOB. These requirements will also be used to evaluate the adequacy of existing concepts to meet these specific physical requirements.

The functional capabilities are based upon current practice and doctrine for Navy ships, where appropriate. For new missions, such as landing strategic cargo aircraft on the MOB, new capabilities requirements have had to be identified as part of the requirements definition process.

Functional Requirements Database

OVERVIEW

The method of decomposing the MOB's various missions into specific functional requirements also serves as the basis for the development and contents of a hierarchical database established to serve as a tool in defining MOB functional requirements. This database serves as a repository for all

currently envisioned mission elements, and the associated capabilities and physical requirements. Each entry into the database is annotated with references and dates so that mission elements, capabilities and requirements can be updated as MOB applications and technology evolve.

The database is structured with mission elements at the top level, with each element linked to the platform capabilities needed to meet that mission element. Each capability is in turn linked to all of the specific functional and physical requirements needed on the MOB to meet that capability. Because the top level of the database consists of individual *mission elements* instead of the four CONOPS representing an overall mission, it allows the user to build new missions from the list of elements and not be tied to the four missions selected for initial CONOPS development. This helps ensure that the database and the requirements documented in it will remain useful tools for the MOB program as missions and CONOPS for the MOB evolve with time.

EXAMPLE ILLUSTRATING STRUCTURE AND CONTENTS OF DATABASE

The following example illustrates the types of information and links contained within the database, and how it can be used to develop a set of physical requirements based on mission elements for the MOB.

For the MOB mission of providing logistics support to a wide range of forces, one mission element might be "Reinforce an Amphibious Task Force (ATF) for an Amphibious Operation. Each mission element is typically linked to a number of different capabilities considered requirements for meeting that mission element. As described earlier, each of these "platform capabilities" represents a more specific function that must be provided by

or supported by the MOB to meet a particular mission element. For example, 41 specific platform capabilities are identified within the database required to support the mission element of “Reinforce an Amphibious Task Force”. Some of these are:

- Stow All Cargo Vehicles
- Selectively Retrieve (or Stow) Any Specific Type of Combat Vehicle and Load (or unload) the Vehicle With (or of) Mission Specific Equipment”
- Offload Bulk Liquids
- Locate, Identify, and Track all Cargo
- Provide Accommodations and Hotel Services to Embarked Military Personnel
- Accomplish Selective Re-supply of Amphibious Ships In-Stream
- Selectively Retrieve or Stow a Designated Portion of the Cargo at the Pallet Level of Breakdown
- Convey Vehicles and Cargo To/From Flight Deck (Air Lift)
- Convey Vehicles and Cargo To/From Ramp Deck(s) (RO/RO)
- Convey Vehicles and Cargo To/From Crane Deck (LO/LO)

Each platform capability is achieved by having the MOB meet the specific physical functional requirements needed to provide that capability. Each platform capability will typically require several functional requirements on the MOB. In following the example from above one level further, to meet the platform capability requirement for “Stow Vehicular Cargo”, in meeting the mission element of “Reinforce an

Amphibious Task Force”, the specific functional requirements that would need to be satisfied in the MOB design include:

- Provide Unobstructed Roadways and Ramps Between Vehicle Stowage Locations and Appropriate Staging/Transfer Locations
- Provide Climate Controlled Spaces for All Vehicle and Aircraft Stowage/Staging and Maintenance Areas, With a Temperature/Humidity not to Exceed 80°F/60% in Summer or be Below 40°F/40% in Winter
- Provide Ventilation Fans With a Capacity of Six Air Changes Per Hour for All Vehicle and Aircraft Stowage, Staging and Maintenance Spaces, Based on Empty Volume
- Provide Vehicle Deck Heights Commensurate With Clearance Requirements of MARCORPS MAGTF Vehicles

In cases where more detailed engineering information is available, the database also links these requirements to specific data tables, text references, pictures and video. For example, the last requirement cited above, “Provide Vehicle Deck Heights Commensurate With Clearance Requirements of MARCORPS MAGTF Vehicles”, is linked to Table 1, below, within the database to provide the designer with the specific information needed to design the vehicle space in accordance with currently defined Marine Corps requirements.

Vehicle Height (ft)	Percentage of Total Vehicle Square Area
$h < 7.5$	52.6

$7.6 < h < 10.5$	23.9
$10.5 < h < 15.5$	21.8
$15.5 < h$	1.7

TABLE 1. MARCORPS MPF Load-Out Vehicles

USES FOR DATABASE

For the purposes of the S&T program, the database serves the following functions:

- Tool for conducting sensitivity analyses to determine the impact that changes in missions will have on the physical requirements for the MOB
- Database “output” in terms of functional requirements for a particular mission serves as the input to the Design Synthesis Model for either evaluating how well a particular concept design meets these requirements, or estimating the geometry of a notional MOB based specifically on the requirements.
- Summarizes consistent physical requirements to be provided as guidance to MOB concept developers.
- Documents the requirements derivation process
- Serves as a repository for mission-based requirements for the MOB that allows requirements to be updated as missions and technology evolve.

In addition, if an acquisition program for MOB is initiated, the database will be available to future MOB planners and designers to use as a tool in developing the physical requirements for the MOB.

Major Drivers in Requirements Derivation

In the course of deriving the physical requirements for the MOB, it has become evident that some mission elements and associated capabilities have a greater impact on the physical requirements for the MOB than others. At this time, the following major mission elements are expected to be part of any future MOB mission, and are expected to drive the physical requirements of the MOB.

PHYSICAL OPERATING ENVIRONMENT

The weather and sea states that the MOB must withstand during transit and on station (in both connected and disconnected configurations) will influence structural, propulsion and station-keeping system requirements.

GENERAL PERFORMANCE REQUIREMENTS

Transit speed and range will drive propulsion system requirements. Overall system operational availability requirements will drive all critical systems.

AIRCRAFT OPERATIONS

Aircraft operations requirements are expected to drive the ultimate size of the MOB, as length requirements are tied to aircraft type, payload and fuel load required for a particular range and mission. The sortie rate for aircraft operations will impact width of the MOB in terms of taxiway and aircraft parking requirements. Identification of the type and number aircraft requiring shelter at the MOB may drive topside space requirements for hangaring aircraft that may be too large to be sheltered below decks, and will drive below decks space requirements, and elevator or ramp requirements. Aircraft operations fuel requirements also will drive liquid cargo storage and distribution requirements on the MOB.

PERSONNEL ACCOMMODATIONS

The MOB must have the capability to provide personnel support facilities for the following categories of personnel:

- MOB crew responsible for day-to-day operation and maintenance of the MOB platform and organic systems (permanent).
- Unit personnel attached to organizations stationed at the MOB for the duration of a particular mission (long-term).
- Unit personnel using the MOB as a temporary staging point to marry up with unit equipment in preparation for deployment to an objective site (short-term).
- Non-military personnel, such as refugees or prisoners of war, requiring temporary personnel support facilities prior to relocation (mid-term).

The type and extent of personnel support facilities requirements will differ for each category listed above. Facilities requirements will consist of berthing spaces, messing facilities, medical and dental facilities, recreational facilities, and quarantine or secured facilities for certain groups of personnel. These facilities in turn drive internal space requirements, arrangements, and utilities requirements.

CARGO STORAGE AND HANDLING

Requirements for storing and accessing vehicular, containerized, palletized, and liquid cargo will drive internal space requirements and arrangements.

ORDNANCE FACILITIES

Special considerations for the amount and type of ordnance stowed, handling and transferred at the MOB will drive internal arrangements. Survivability against accidental detonation will impact structural requirements.

CARGO TRANSFER

Cargo transfer operations between the MOB and sea-going vessels will dictate the number and type of berthing and/or mooring locations required at the MOB, and cargo handling system requirements. This is anticipated to include transfer of cargo to vessels ranging from lighterage to sealift support vessels, commercial containerships, and tankers, and include Lift-On/Lift-Off (LO/LO), Roll-On/Roll-Off, and liquid cargo transfer operations.

ASSIGNED AND TRANSIENT UNIT EQUIPMENT AND FACILITIES

Space for equipment and operations of organizations assigned to the MOB will drive both topside and below decks space requirements and arrangements.

SURVIVABILITY

The physical requirements of the structure will be greatly impacted by the requirement to withstand attack from 21st century anti-ship missiles, torpedoes and mines.

Conclusion

The ultimate goal of ONR's S&T program for the MOB is to establish technical and financial feasibility of a MOB capable of meeting mission-based requirements. Towards this end, efforts are well underway in the advancement of those technologies critical to reducing the technical,

operational and financial risks of designing, constructing, operating and maintaining a MOB. As part of this effort, a requirements definition process and baseline set of mission-based requirements was developed. These will help guide the development and refinement of MOB concepts, establish the basis for a consistent and fair evaluation of alternative concepts, and help verify that the S&T program is focusing its resources on those technology issues most critical to meeting mission needs for a MOB.

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